Quantifying the economic impacts of a policy shift towards legalizing informal milk trade in Kenya

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Improving Market Opportunities
Discussion Paper No. 1

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Table of contents

Abbreviations

AE	adult equivalent
AIDS	Almost Ideal Demand System
CSO	Civil Society Organisation
DFID	Department for International Development
ICRAF	World Agroforestry Centre
ILRI	International Livestock Research Institute
GAMS	General Algebraic Modelling System
GRIPS	Graduate Institute of Policy Analysis
KARI	Kenya Agricultural Research Institute
KCC	Kenya Cooperative Creameries
KDB	Kenya Dairy Board
KSh	Kenya shilling(s)
MoLFD	Ministry of Livestock and Fisheries Development
REPEAT	Research on Poverty, Environment and Agricultural Technologies
RSWEC	Recovery Strategy for Wealth and Employment Creation
SDP	Smallholder Dairy Project
SRA	Strategy for Revitalising Agriculture
SSMV	Small-scale milk vendor
SUR	Seemly Unrelated Regression
USD	United States dollar(s)

1. INTRODUCTION

1.1 Background

Dairy enterprises are the "white gold" of many developing countries, creating pathways out of poverty while boosting human nutrition and health, crop farming and natural resource management. Demand for milk and other dairy products is increasing in many parts of the developing world. Small-scale farmers and traders are at the heart of this sector. The challenge for policymakers is to encourage small-scale operators to share in this growing market while ensuring that poor consumers enjoy safe and affordable dairy products. (ILRI, 2006).

However, inappropriate regulations have been identified as the most important factor that constrains enterprise development in developing countries (Pfeffermann, 2001). Kenya provides a prime example of inappropriate regulations that affect informal milk trade. Here, even though indigenous dairy markets predominate, public officials have actively discouraged them in the past. This is in spite of the many benefits associated with the sector, such as affordable milk for poor consumers, satisfaction of traditional tastes and better prices for producers.

Kenya has a relatively high demand for milk; per capita milk consumption of 80-100 kg liquid milk equivalent is four to five times greater than that of other countries in the region. This implies good opportunities for enhanced income generation for the thousands of Kenyan smallholder dairy producers and their small-scale traditional rural and urban market intermediaries.

The regulations against indigenous dairy milk markets were largely based on perceived quality and safety concerns. However, there was little factual information on the safety of traditionally marketed milk mainly because the national authorities responsible for implementing regulations relied on western models based on costly cold-chain pathways and pasteurization, ignoring the fact that many resource-poor consumers refuse to pay the extra costs thus incurred and prefer to buy raw milk and boil it themselves.

In order to amend the regulations and standards that had negative impacts on small-scale milk markets, there is need to quantify the benefits accrued via this sector. Besides direct benefits of employment and income generation for milk traders, improving small-scale milk markets is expected to improve market access, generate more income for producers and provide cheaper milk products to consumers. The Kenyan dairy development authorities, therefore, urgently require more information as a basis on which to develop locally-derived regulations and standards of dairy safety assurance that also define the required institutional and technical changes and trade-offs.

It is against this background that the Kenya Smallholder Dairy Project (SDP)[1] channelled part of its research efforts to contribute to much-needed policy changes in the Kenya dairy sector. The results generated by the project pinpointed a basic problem in dairy development in Kenya: the need to recognize and develop the informal sector that markets most of the milk in Kenya[2].

Key observations and conclusions with regard to the need to reform the policy environment relating to milk marketing while safe-guarding the public from exposure to milk-borne health hazards in Kenya were as follows:

- A supportive policy environment is needed to aid the development of the Kenya dairy industry.
- The revised policy and legislation need to take full account of broader national goals (such as creation of employment and poverty reduction) and the reality of systems operating in the dairy sector.
- Most raw milk traders operate outside the regulatory environment and are not licensed. However, licensed traders show no significant difference in milk quality from the majority of smaller, unlicensed milk traders.
- Training of raw milk traders leads to clear improvements in milk quality and such training would be most effective within a licensing system that allows the monitoring of accredited business development service providers.
- The universal consumer practice of boiling purchased milk means that the health risks from all marketing channels are minimal.
- The pace of review of relevant national policy and legislation needs to be speeded up.

In working towards a pro-poor dairy policy shift, the core institutions that implemented the SDP worked closely with local civil society organizations (CSOs). The multi-institutional partnership elaborated these scientific facts in various reports and policy briefs and used them in a series of communications events that led to a shift towards a pro-poor policy stance by Kenyan government officials.

Although the resulting changes in national policy are still in the legislative process, changes in attitude and behaviour of key actors toward the informal milk market can already be observed at national and grassroots levels. Relevant government officials have since embarked on processes to formalize the small-scale milk trade sector. One key piece of evidence for this change in attitude is an on-going pilot project led by the national dairy regulator, the Kenya Dairy Board (KDB), to test new institutional mechanisms to formalize small-scale milk trading.

[1] The Smallholder Dairy Project was a collaborative research and development project undertaken by the Ministry of Livestock and Fisheries Development, the Kenya Agricultural Research Institute (KARI) and the International Livestock Research Institute (ILRI) between 1997 and 2005.
[2] See various reports at the SDP website www.smallholderdairy.org.

1.2 Policy context and question

Before the Dairy Industry Act (Cap 336) was enacted in 1958, traditional milk marketing in Kenya was largely unregulated. The Act was introduced mainly to protect the interests of the expanding large-scale settler dairy producers and, despite huge changes in its structure since then, the Kenyan dairy industry is to a large extent still regulated by that Act today.

In 1964, milk quotas were abolished and the Kenya Cooperative Creameries (KCC) became accessible to all farmers, as long as their milk was of acceptable quality. KCC thus became a guaranteed market for raw milk, as it bought any amount of milk supplied by farmers, regardless of demand. However, by the early 1980s, the highly subsidized input services that had been in place had become unsustainable. Liberalization of the dairy industry started in the mid-1980s, with full price decontrol by 1992. KCC, and the new processors who entered the market, now set the price of milk. This heralded the gradual collapse of KCC through the 1990s.

Since then, the dairy sub-sector has witnessed several major changes in the delivery of services and marketing of milk. The collapse of KCC effectively ended its monopoly on milk processing and marketing in the lucrative, high-demand urban areas of Kenya. This gap was quickly filled by a proliferation of small-scale, illegal, informal milk traders and large-scale, licensed and regulated, private sector milk processors and packers. The small-scale traders sold raw milk while their large-scale counterparts sold packaged, pasteurized or ultra-heat treated milk and other processed dairy products.

Although the sale of raw milk in urban areas was illegal, high consumer demand for raw milk meant that the number of small-scale milk vendors (SSMVs) serving various parts of Nairobi and other urban areas in Kenya soon reached tens of thousands. It became virtually impossible for the KDB to control them, and the private dairy companies came to regard the untaxed, unregulated and unlicensed SSMVs as unfair competition.

The SSMVs bought milk from smallholder dairy farmers. Most of these milk vendors operated from fixed premises but some were mobile. Plastic containers were predominantly used and milk was transported to urban centres by bicycle or public transport. Most traders delivered milk to specific customers but some also retailed it in the open market. The milk traders had good networks amongst themselves and mainly operated early in the morning, partly in response to demand from consumers but also to avoid harassment by KDB inspectors.

Although the dairy industry has been dominated by small-scale production and marketing from the 1990s to the present, this has been in a policy environment that interpreted the informal market as illegal. Since 1995, the government has been trying to reform the legal and policy framework to better reflect the way the industry has developed, although with little progress before the SDP started in 1997.

Poverty reduction and employment generation are important goals in various development strategies and policies in Kenya including the recent Recovery Strategy for Wealth and Employment Creation (RSWEC, 2003–2007) and the Strategy for

Revitalizing Agriculture (SRA, 2004–2014). These documents recognize that dairy activities generate many employment opportunities in the course of milk production, processing and marketing.

Approximately 6 million litres of milk is traded daily in Kenya through formal and informal milk marketing pathways. Thus, beyond the farm level, processing and marketing of milk and other dairy products offer numerous employment and income-earning opportunities for the various participants in the milk supply chain, such as transporters, mobile milk traders, milk bars and shops/kiosks.

It has been shown that dairy production, marketing and consumption are predominantly driven by consumer demand. Consumers show a clear demand for unprocessed milk, based on affordability, availability and taste. In turn, this demand has supported the maintenance of a strong market for unprocessed milk with a variety of informal milk market agents. Most smallholder dairy producers, therefore, sell their milk into this market whereas others sell through chains that supply the processors. This makes SSMVs an important milk outlet for smallholder milk producers. A policy that affects any level of the milk supply chain will therefore have an impact not only on the players at that particular level but on all the players along the supply chain, including producers, marketers, processors and consumers.

The SDP had significant policy impacts, particularly in the area of changing perceptions and policies towards small-scale milk traders and agents (Leksmono *et al.*, 2006). Although the reforms initiated by the SDP have not yet been officially formalized and the supply of raw milk to scheduled areas is still technically illegal, a marked change in attitude and implementation has already taken place, particularly by KDB officials.

There have also been repeated official public announcements by the Ministry of Livestock and Fisheries Development (MoLFD) and KDB emphasizing the plan to bring the raw milk traders into the regulatory system through training and licensing. Already many SSMVs have received licenses and are operating freely without harassment.

While this policy shift towards legalizing informal milk traders is noteworthy, its economic impacts on small farmers and consumers in terms of price and/or employment have not yet been quantified. This study, therefore, seeks to quantify the impacts resulting from this pro-poor policy shift. The analysis aims to quantify the direct and indirect impacts on poor producers, market agents and consumers of the on-going change in the Kenya dairy policy towards legitimizing small-scale informal milk market agents.

Most policy analysis studies examine the impact of price changes, particularly the economic impact of agricultural price (tax/subsidy) policies (Braverman *et al.*, 1987; Braverman and Hammer, 1986). Others examine the impact of food aid (Dorosh *et al.*, 1995). This study adds to these analyses another dimension that looks at the reduction of transaction costs along the supply chain, and how this has an impact on various players along the chain.

Our hypothesis is that the policy shift towards legalizing raw milk sales will lead to lowered transaction costs, which in turn will have an impact on various players along the supply chain and the consumers as well. We therefore endeavour to quantify these impacts.

1.3 Transaction costs

Transaction costs are the embodiment of barriers to market participation by resource poor smallholders (Holloway *et al*., 2000). According to Staal *et al.* (1997), transaction costs include the cost of:

- searching for a partner with whom to exchange,
- screening potential trading partners to ascertain their trustworthiness,
- bargaining with potential trading partners (and in some cases officials who can hold up trade) to reach an agreement,
- transferring the product (this typically involves transportation, but could also include processing, packaging and securing title),
- monitoring the agreement to see that its conditions are fulfilled, and
- enforcing (or seeking damages for any violation of) the exchange agreement.

Distance from the market and poor infrastructure increase transportation costs. On the other hand, high marketing margins are mainly due to merchants with local monopoly power. Search and recruitment costs are made higher due to imperfect information or inadequate access to information. Differential transaction costs among households thus stem from asymmetries in access to assets, information, services and remunerative markets. In essence, all transaction costs derive from a combination of bounded rationality (which reflects both imperfect information and a limited capacity to analyze it) and opportunism, which Williamson (1996) defines as "self-interest seeking with guile".

One implication is that the combination of rational choice behaviour and transaction costs creates incentives for opportunistic behaviour, resulting in adverse selection and moral hazard in transaction, both of which have high costs. The former implies *ex ante* costs of screening out the bad risks among candidates for the transaction while the latter implies *ex post* costs of monitoring, legal action and enforcement. This gives rise to the quest for institutions, whether alternative or complementary to the market, that place checks on opportunism and reduce transaction costs.

In the dairy industry, transaction costs also increase because raw milk is a highly perishable product. Lowering transaction costs would therefore increase the volumes of milk traded with economic benefits to traders and producers. Increased volume of livestock trade would promote regional trade and integration (Williams *et al*., 2006).

In Kenya, the failure of KCC created a problem for producers and cooperatives. They had to face the uncertainty of unreliable milk outlets. This gave rise to many SSMVs who sold raw milk, though the sale of raw milk was illegal in urban areas. The result was that the SSMVs faced a different type of transaction cost. Because the sale of raw milk in urban areas was illegal, informal milk traders risked being arrested by the police and having their milk confiscated and dumped. To avoid this, some would pay bribes to the police or KDB officials. All these amount to high or increased transactions costs.

A policy shift towards legalizing the sale of raw milk is likely to reduce these transaction costs. Eliminating or lowering these transaction costs should have an impact not only on the traders but also on the producers and consumers through a change in price and resulting indirect effects. The policy instrument affected is an indirect one via reduced transaction costs along the milk marketing channel as a result of the policy change.

2. THEORETICAL FRAMEWORK

In order to assess the economic impact of the legalizing milk trade by informal vendors, we utilized a partial equilibrium framework that incorporates the major channels involved in milk production, trade and related markets. The relative importance of each of these marketing channels is illustrated in figure 1. Direct sales by producers to consumers represent the largest share of marketing flows (42 percent), with trade via SSMVs comprising 23 percent. Other important flows include sales via milk bars and cooperatives for raw milk, while processed milk only accounts for about 14 percent of total sales.

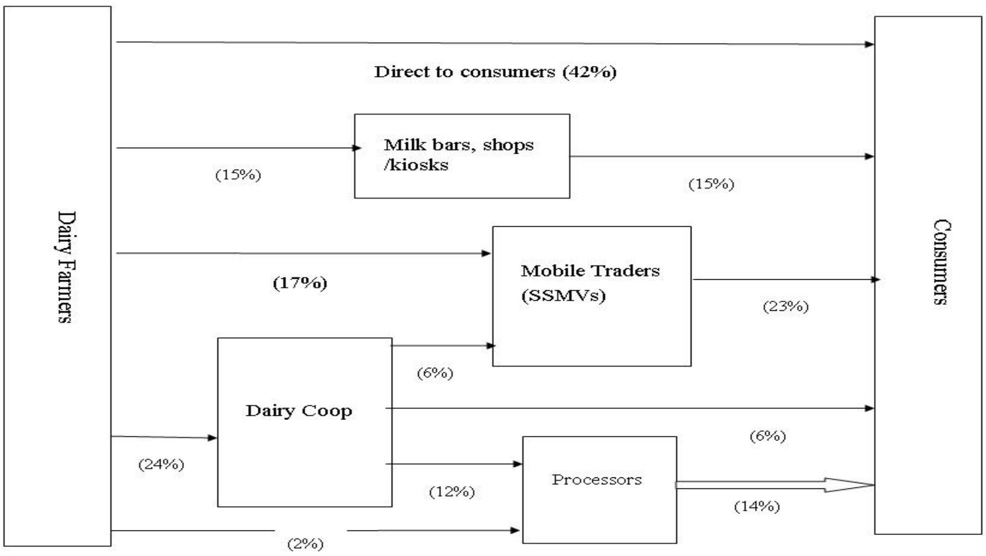

Figure 1: Marketing chains for marketed milk in Kenya

We can highlight the intuition behind the expected impact of legalizing SSMVs using a simplified partial equilibrium representation of these relationships. Consider the three main stakeholders in this marketing chain: producers (P), traders (T) and consumers (C). Producers sell a share of their production, γ, to consumers, with the remainder, $1 - \gamma$, to traders. Consumers, likewise, purchase a portion, δ, direct from producers and the remaining $1- \delta$ from traders.

We illustrate these relationships graphically in figure 2 using three supply-demand graphs: the top panel shows direct sales from producers to consumers, the middle panel sales from producers to traders, and the bottom panel sales from traders to consumers. In the figure, *pp* represents the producer (farm-gate) price, *pc* is the price paid by the consumer, and the vectors **X**, **Y**, and **Z** are miscellaneous parameters related to tastes, complements and substitutes; technical parameters; and income for consumers, traders, and producers, respectively.

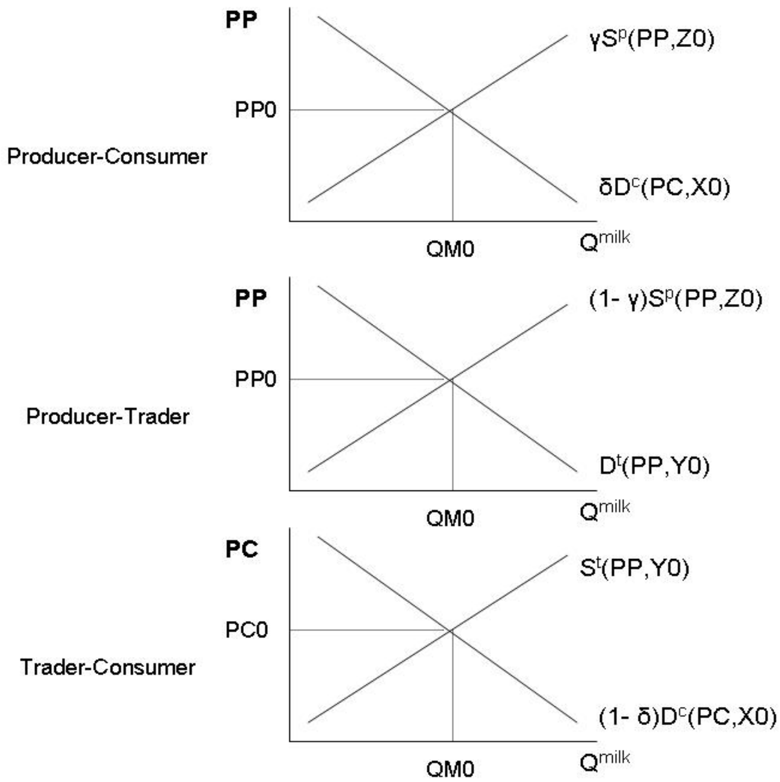

Figure 2: Partial equilibrium representation of major markets in the dairy sector

With the change in policy towards the legalization of SSMVs, an important first-round effect was a significant decline in various transactions costs incurred by traders. A reduction in such costs would increase demand from traders and induce entry into the sector. In a partial equilibrium framework, this would entail a rightward shift in demand from traders in the producer-trader sector as illustrated in figure 3, as lower transaction costs would change the vector **Y** from its initial value (**Y0**) to a new level, **Y1**. This would cause an increase in the price paid to producers from PP0 to PP1. Also, since input demand for milk by traders is analogous to the supply of milk available from traders to consumers (figure 3, bottom panel) there would be a rightward shift in the supply curve in the trader-consumer market that would induce a fall in the price paid by consumers from PC0 to PC1. Since the profits received by traders can be denoted as $\pi = (PC - PP)Q^{milk} - TC - C$, these effects would cause a decline in the marketing margin *(PC-PP)* received by small traders, which would be offset by greater volumes of milk marketed (Q^{milk}) and lower transactions costs (*TC*). Such a policy change would naturally impact own and related markets as well.

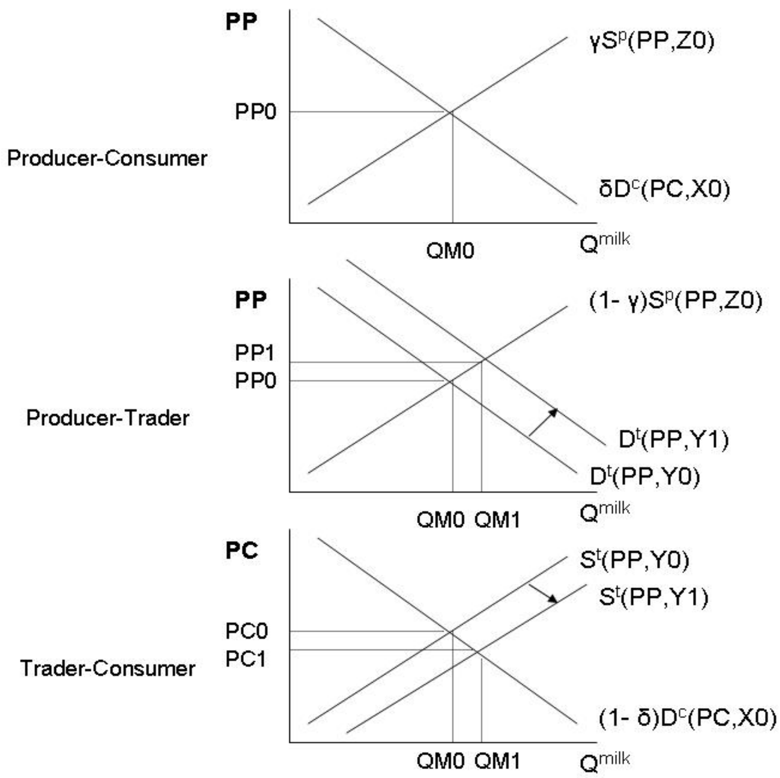

Figure 3: Impact of reduced transactions costs on milk traders

In order to determine the magnitude of economic impacts in own and related markets, a multi-market model according to the method of Rich and Lundberg (2002) was used and run in the General Algebraic Modelling System (GAMS). Specific details of the model are in Appendix A. The model includes two output markets (milk and maize), four input markets (fertilizer, labour, Napier and concentrates) and a housing sector to proxy for non-food expenditures. The model distinguishes between three production systems in supply (subsistence, major and limited dairy enterprises) and four household consumption groups (urban poor, urban non-poor, rural poor, and rural non-poor) to examine the distributional impact of reforms to the informal milk sector.

Reforms associated with the legalization of SSMVs were modelled by assuming a 38 percent reduction between the producer price and the consumer price. This level of price reduction was arrived at using data provided by six traders. The traders provided data on transaction costs they incurred before the policy change. These costs were quantified in terms of bribes to police, discarded milk and confiscated milk cans. We then calculated the transaction costs as a percentage of the total market margins accruing to traders (total revenues less procurement costs). Ideally, one would directly model the impact of reduced transactions costs on trader behaviour, but data limitations precluded such an approach.

3. DATA AND ESTIMATIONS

3.1 Consumption data

Household survey data collected by SDP in 1998 from Nairobi, Nakuru urban and Nakuru rural were used to describe household consumption characteristics. The survey collected detailed information on the household structure, consumption, prices, incomes and housing characteristics among others. The data set thus included consumption data on food and non-food items. However, this study only considered consumption data on raw milk, whole maize grain and housing.

Raw milk consumed included both raw milk purchased and that produced and consumed at home. The same applied to maize grain. Purchase prices for raw milk and maize grain were used. Per capita income, expenditure and consumption of the three items were also derived from that data set.

The data set consisted of 406 households: 129 rural and 277 urban. The households were further classified as poor or non-poor based on a monetary poverty line that represents the cost of a basic basket of goods (Central Bureau of Statistics, 2003). The poverty line is based on the expenditure required to purchase a food basket that allows minimum nutritional requirements to be met. This is set at 2,250 calories per adult equivalent per day (AE), in addition to the costs of meeting basic non food needs (Government of Kenya, 2000). In Kenya, this poverty line was estimated to be KSh. 1,239 and KSh. 2,648 per AE per month for rural and urban households, respectively, based on data collected in 1997.

Because the income data available in the data set was in terms of income categories rather than exact income, total expenditure data was used to calculate per capita expenditure and determine the position of the households against the poverty line. Based on their position from the poverty line four types of households were analyzed: rural poor, rural non-poor, urban poor and urban non-poor. The poor were those below the poverty line, whereas the non-poor were those above it. Of the 406 households, 312 consumed either maize grain or raw milk or both and so the estimations were based on these 312 households.

The demand parameters were estimated econometrically following the Almost Ideal Demand System (AIDS) as budget shares (w_i). The estimated demand equations take the form:

$$\boldsymbol{w}_{\boldsymbol{i},\boldsymbol{h}} = \alpha_{\boldsymbol{i},\boldsymbol{h}} + \sum \phi_{\boldsymbol{i},\boldsymbol{h}} \ln \boldsymbol{PC}_{\boldsymbol{i},\boldsymbol{h}} + \varphi_{\boldsymbol{i},\boldsymbol{h}} \ln \frac{\boldsymbol{y}_{\boldsymbol{h}}}{\boldsymbol{P}_{\boldsymbol{h}}}$$

$$\boldsymbol{i} = 1,2,\ldots 5$$

Where $w_{i,h}$ is the budget share of the ith good by household h and y is the total expenditure by household h on the three goods. P is a price index defined as:

$$\ln P = \sum_i w_i \ln PC_i$$

The parameters are subject to the following restrictions:

$$\sum_i \alpha_i = 1 \ \sum_i \phi_{ih} = 0 \ \ \boldsymbol{i}\sum \varphi_i = 0 \ \sum_h \phi_{hi} = 0, \ \ \phi_{ih} = \phi_{hi}$$

The AIDS is estimated as a system of demand equations with the above restrictions imposed using the Seemingly Unrelated Regression (SUR). The price and income elasticities were derived from the parameter estimates as:

$$E_{ii} = -1 + \frac{\phi_{ii}}{w_i} - \varphi_i, \qquad E_{ih} = \frac{\phi_{ih}}{w_i} - \frac{\varphi_i}{w_i} w_h, \qquad \eta_i = 1 + \frac{\varphi_i}{w_i}$$

Expenditure per capita for each household group was calculated by dividing the total household expenditure by the number of household members. Tables 1, 2, 3, 4 and 5 show total monthly household expenditure on the three items, monthly per capita consumption, expenditure shares, income elasticities and price elasticities, respectively.

Table 1: Total monthly household expenditure (KSh.) on maize grain, raw milk and housing

Household type	**No. of households**	**Maize grain**		**Milk**		**Housing**	
		Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Urban poor	51	231	317	201	209	517	286
Urban non-poor	134	154	270	470	773	2802	6586
Rural poor	48	334	388	506	666	43	126
Rural non-poor	79	351	478	901	1154	70	241
All households	**312**	**244**	**367**	**541**	**848**	**1313**	**4504**

Among the foods, milk accounted for the greatest expenditure in all household types except the urban poor. This result is consistent with that of Argwings-Kodhek *et al.* (2005) where dairy products constituted the largest food expenditure.

Table 2: Proportions of expenditure shares

Household type	**Maize grain**	**Milk**	**Housing**
Urban poor	0.23	0.20	0.56
Urban non-poor	0.11	0.23	0.66
Rural poor	0.41	0.55	0.04
Rural non-poor	0.28	0.67	0.05

Among urban dwellers, the largest share of their expenditure to was on housing, as compared to their rural counterparts whose largest household expenditure was on milk followed by maize. Out of the 129 rural households, only 22 respondents paid rent with the rest living in their own houses.

Table 3: Income elasticities for the three consumption goods

Household type	Maize grain	Milk	Housing
Urban poor	1.05	1.0	0.67
Urban non-poor	1.05	1.49	0.75
Rural poor	1.2	1.0	0.50
Rural non-poor	1.12	0.95	0.40
All households	**1.11**	**1.15**	**0.71**

The income elasticities for maize grain were high. However, they are close to one which, theoretically, is the upper limit for staples. The income elasticities for milk are essentially in line with what other studies have obtained. Staal *et al*. (2003) found the income elasticity of raw milk to be 1.192.

Table 4: Price demand elasticities

Price/commodity	Maize grain	Milk	Housing
Maize grain price	-1.04	-0.07	0.02
Raw milk price	-0.04	-0.97	-0.01
Housing price	-0.18	-0.18	-0.70

The price demand elasticities are essentially similar to what other studies have found. For example, Dorosh *et al*. (1995) found an own price white maize elasticity of -0.85.

3.2 Production data

Basic production data on producer prices, outputs and inputs were taken from the REPEAT (Research on Poverty, Environment and Agricultural Technologies) data set collected by a team of researchers from the National Graduate Institute for Policy Studies (GRIPS) in Japan, Tegemeo Institute of Egerton University, the World Agro-forestry Centre (ICRAF), and the International Livestock Research Institute (ILRI).

The data extracted included output levels and levels of input use for maize and milk. The inputs considered were labour and fertilizer for maize; and labour, concentrates and Napier/stover for milk.

The sample households were characterized into three production systems according the characterization by the Trajectories of Change project (http://www.trajectories.org). The three production systems were: subsistence farmers with limited dairy; farmers with major dairy activities and export cash crops; and farmers with limited dairy activities and export cash crops. To link the production to the consumption data, it was assumed that households in the subsistence production systems were the "rural poor" and those in the other two production systems were the "rural rich". None of the households in the REPEAT data set were located in urban areas.

Land for both commodities was assumed to be given (fixed). A log linear profit function was used to derive both the output supply and the input demand equations. The output equation for maize and milk is thus represented in a log linear form as a function of the output and input prices as shown below:

$$Ln(outp_{j,p}) = \alpha_{j,p} + \sum_j \beta_{j,p} Ln(PP_{j,p}) + \sum_i \delta_{i,j,p} Ln(PI_{i,p})$$

Where $PP_{j,p}$ are the output prices differentiated by production systems and $PI_{i,p}$ is a vector of input prices in each production system.

The input demand equations are similarly represented in a log linear form as a function of the output and the input prices as shown below.

$$Ln(inp_{i,j,p}) = \alpha_{i,j,p} + \eta_{i,j,p} \; Ln(PI_{i,p}) + \sum \gamma_{i,j,p} Ln(PP_{j,p})$$

Where as before $PI_{i,p}$ are the input prices in the different production systems and $PP_{j,p}$ are the output prices in the different production systems.

The input demand and output supply functions are estimated to give the production parameters. The beta (β) and the delta (δ) coefficients represent the price elasticities in the output equations, and η and γ represent the price elasticities in the input demand equations. The estimations were done using the Seemingly Unrelated Regression (SUR) as a system and with symmetry conditions imposed.

What follows are the results of the estimations that were used to parameterize the model. Table 5 shows the production levels for maize and milk in the base data. Table 7 shows the output supply elasticities with respect to output prices. Table 8 shows the output supply elasticities with respect to input prices.

Table 5: Production levels (total annual output) for maize and milk by production system

Production system	Maize (kg)	Milk (kg)
Subsist	4161	2561
Mdairy	8720	5319
Ldairy	6567	3953

Subsist: subsistence farmers with limited dairy
Mdairy: major dairy activities with export cash crops
Ldairy: limited dairy activities with export cash crops

Table 6: Output supply elasticities with respect to output prices

Production system	Maize price	Milk price
Subsist maize	0.83	0.31
Mdairy maize	0.17	-0.16
Ldairy maize	0.74	-0.05
Subsist milk	0.31	0.35
Mdairy milk	-0.16	0.40
Ldairy milk	-0.05	0.34

Own price elasticities were all positive as theoretically expected. The cross price elasticities were positive in the subsistence production system and negative in the other two systems. In the subsistence with limited dairy production system, maize and milk complemented each other. It has been noted that in subsistence production systems, sale of dairy products like milk provides cash that is used to purchase inputs such as fertilizer for crops (Bebe, 2003). In the non-subsistence production systems, farmers are possibly more commercial-oriented and allocate resources based on the profitability of the commodities. Hence the competition for available resources, particularly land and labour.

Table 7: Output supply elasticities with respect to input prices

Production system	Fertilizer	Labour	Napier	Concentrates
Subsist maize	-0.94	-0.32	na	na
Mdairy maize	-0.29	-0.01	na	na
Ldairy maize	-0.14	-0.03	na	na
Subsist milk	na	-0.04	-0.08	-0.13
Mdairy milk	na	-0.34	-0.19	-0.07
Ldairy milk	na	-0.03	-0.07	-0.14

na: not applicable

The output elasticities with respect to input prices were generally in line with theoretical expectations. It was however not clear why the maize output elasticity with respect to the price of fertilizer was much higher in the subsistence production system.

Table 8: Input demand elasticities with respect to input prices

Input by production system	Fertilizer	Labour	Napier	Concentrates
Subsist fertilizer	- 1.01	- 0.03	0	0
Mdairy fertilizer	- 1.10	0.09	0	0
Ldairy fertilizer	- 0.56	0.06	0	0
Subsist labour	- 0.03	- 0.39	- 0.04	0.47
Mdairy labour	0.09	- 0.31	- 0.08	0.03
Ldairy labour	0.06	- 0.03	- 0.06	0.12
Subsist Napier	0	- 0.04	- 0.94	-0.13
Mdairy Napier	0	- 0.08	- 0.13	-0.18
Ldairy Napier	0	- 0.06	- 0.12	-0.09
Subsist concentrates	0	0.47	-0.13	- 1.36
Mdairy concentrates	0	0.03	-0.18	- 1.53
Ldairy concentrates	0	0.12	-0.09	- 2.33

The input demand elasticities with respect to input prices in Table 8 were generally in line with theoretical expectations. Napier and labour are complements as labour is required to cut and process the Napier. The input demand elasticities with respect to output prices are in line with theoretical expectations (Table 9). However, except for fertilizer, the responses (elasticities) are very low.

Table 9: Input demand elasticities with respect to output prices

Input by production system	Maize	Milk
Subsist fertilizer	0.94	0
Mdairy fertilizer	0.29	0
Ldairy fertilizer	0.14	0
Subsist labour	0.32	0.04
Mdairy labour	0.01	0.34
Ldairy labour	0.03	0.03
Subsist Napier	0	0.08
Mdairy Napier	0	0.19
Ldairy Napier	0	0.07
Subsist concentrates	0	0.13
Mdairy concentrates	0	0.07
Ldairy concentrates	0	0.14

3.3 Market margins (transaction costs) data

Data on the market margins (transaction costs incurred by the traders before the dairy policy change) were obtained by interviewing a sample of six traders on the before-and-after scenarios. Specifically, we sought information on amounts of milk lost due to confiscation by police, amount of milk that went sour, amount of bribes given and the number and cost of cans confiscated before and after the change in dairy policy.

The major losses were in terms of the costs of confiscated milk and milk containers. Of the six traders interviewed, only one used to pay bribes regularly, and another had paid a bribe only once. The trader who used to pay bribes did not experience harassment from the authorities. Table 10 shows the average level of transaction costs in terms of quantity and value. None of the traders indicated that their milk went sour.

Table 10: Milk volumes traded and losses incurred by milk traders before and after the dairy policy shift

Item	Before	After
Average daily milk sales (litres)	62.5	116
Price of milk (KSh./litre)	19.9	21.9
Value of daily milk sales (KSh.)	1244	2549
Change in daily milk sales (litres)		+53.3
Value of increased milk (KSh.)		+1194
Monthly milk poured/lost due to harassment (litres)	142	0
Value of lost milk (KSh.)	2661	0
Amount of bribe given in one month (KSh.)	41.7	0
Value of cans lost in one month	598	0

After the change in the dairy policy, the average daily amount of milk sold per trader increased by 85.3 percent, from 62.3 to 116 litres. When all the costs are considered, this represents a 38 per cent decrease in market margins. It is important to note that the monthly bribe of KSh. 41.7 is consistent with the results of a wider (public health) survey.

4. RESULTS AND DISCUSSION

The analysis is according to the multi-market model described in appendix A and considers a 38 per cent change in marketing margins between producer and consumer prices. We thus examined the impact of this change in consumer and producer prices, on agricultural incomes and levels of household production, consumption and incomes. Tables 11and 12 show the effects the reduced trader market margins on input and output prices.

Table 11: Effects of a thirty eight percent decrease in market margins on the consumer prices

Commodity	Base consumer price	New consumer price	Percentage change in consumer price
Maize	14.1	14.2	0.92
Milk	23.4	20.2	-13.5
Housing	1.312	1.362	3.81
Labour	130.9	131.4	0.42
Fertilizer	29.7	29.7	0
Napier	7.15	7.18	0.36
Concentrates	12.98	12.98	0

The reduced market margins resulted in a 13.5 percent decline in the consumer price of milk. This result is consistent with our hypothesis that a reduction in the transaction costs will not only have an impact on the traders but on the related agents (producers and consumers) too. A decrease in the market margins for the traders is likely to make milk trade more lucrative and provide incentives for more traders to become involved in the milk market, hence a shift in the trader supply curve to the right. Because the consumer demand curve does not shift, the consumer price is reduced (see the theoretical framework).

The change in the market margin resulted in only a slight change in the consumer and producer prices of maize (less than 1 per cent). The price of housing was found to increase by 3.81 per cent. This may be because the reduced price of milk enabled households to save on expenditures on milk and use the savings on other commodities such as housing.

For the non-tradable inputs (Napier and labour) the reduction in market margins resulted in a less than 1 per cent increase in the prices of both inputs. However, the prices of fertilizer and of concentrates did not change because they are fixed to the world market prices.

Table 12: Effect of a thirty eight percent decrease in market margins on producer price

Commodity	Base producer price	New producer price	Percentage change in producer price
Maize	12.6	12.7	0.92
Milk	15.1	15.1	0
Housing	1.313	1.363	3.81
Labour	119	119.5	0.42
Fertilizer	27	27	0
Napier	6.50	6.52	0.36
Concentrates	11.8	11.8	0

As explained in the theoretical framework, the decline in market margins should also lead to an increase in the producer price. However, the output price of milk did not change because milk was treated as an exportable good in the model and its producer price fixed to the world market price. This is a shortcoming of the model. There was not enough data to model the behaviour of the milk traders and hence it was not possible to vary the producer price of milk based on market forces. However, this result reflects reality in that a reduction in transaction costs is most likely, in the short run, to have a bigger impact on consumer prices than on producer prices. In a competitive market environment it is plausible that the first-round effect of reduced transaction costs is for the traders to pass this cost reduction on to consumers in terms of lower retail prices because the marginal costs of trading are also reduced.

Table 13: Effect of a thirty eight percent decrease in the traders' market margins on the supply of commodities

Production system	Maize			Milk		
	Base production	**New production**	**Percentage change**	**Base production**	**New production**	**Percentage change**
Subsist	124.852	125.633	0.63	322.082	322.848	0.24
Mdairy	787.034	788.222	0.15	1174.191	1169.715	-0.38
Ldairy	1693.418	1704.665	0.66	2519.593	2517.505	-0.08
All households	**2605.304**	**2618.519**	**0.51**	**4015.866**	**4010.068**	**-0.14**

Reduced marketing margins saw in a slight increase in the production of maize and a slight decrease in the production of milk (Table 13). The increase in maize production is mainly in the subsistence with limited dairy and the limited dairy with export crops production systems. Maize output in the major dairy with export crops production system increased the least. This is mainly because of the nature of the maize output response to price in the different production systems. Outputs in the subsistence system and the limited dairy system are more responsive to output price (have higher price elasticities). Maize output in the major dairy production system is the least responsive to maize output price (has the lowest elasticity).

Milk production in the subsistence with limited dairy production system increased by 0.24 per cent but this increase was offset by the production decrease in the other two production systems, particularly in the major dairy with export crops. Given that the producer price of milk is fixed, the reduction in production is driven mainly from the input side, particularly labour and Napier whose prices increased by 0.42 and 0.36 per cent, respectively.

Similar to maize production, the observed scenario between the production systems is again influenced by the observed elasticities. Milk output in the major dairy production system is more responsive to the prices of labour (η = -0.19) and Napier (η = -0.34) compared to the other two production systems (Table 8). The increase in the prices of labour and Napier results in a decrease in the purchase of these inputs mainly in the major dairy productions system leading to a bigger decline in milk production in that system.

Table 14: Effect of a thirty eight percent decrease in traders' market margin on consumption levels of commodities by different household types (percentage change)

Household type	Maize	Milk	Housing
Urban non-poor	0.14	14.99	-0.18
Urban poor	0.14	14.99	-0.18
Rural non-poor	0.52	15.36	0.16
Rural poor	0.51	15.34	0.13
All households	**0.51**	**15.35**	**0**

Results of the impact of the reduction in transaction costs on the consumption levels are shown in Table 14. They show that the biggest impact of the reduction in the market margins was in the consumption levels of raw milk, mainly because of the impact it has on the consumer price of milk. Consumption of raw milk increased for all household types by about 15 per cent.

In terms of welfare effects, this has two implications. Firstly, the increase in the consumption of milk particularly in the rural areas will lead to improved nutrition, particularly among children. Secondly, a decrease in the consumer price of milk will have an impact of the real incomes of the households in that they will require less money to purchase a given bundle of goods. This impact will be highest for rural households where milk forms a high percentage of their expenditures (Table 2).

The 38 per cent reduction in market margins resulted in a slight increase in consumption of maize grain among all household types, though this increase was slightly higher in rural households. This was because the incomes of rural households increased slightly despite the increase in the consumer price of maize while the incomes of the urban households remained the same.

Table 15: Effect of a thirty eight percent decrease in the market margin on household income (percentage change)

Household type	Change in household income	Change in agricultural income
Urban non-poor	0	0
Urban poor	0	0
Rural non-poor	0.34	0.41
Rural poor	0.31	0.63

The reduction in the market margins resulted in only a small increase in household income for the rural households (Table 15). This increase was from the slight increase in agricultural income from increased maize production and price (Tables 12 and 13). With the price of milk fixed and that of some of the inputs increasing, little impact can be expected on the producer side of the economy. Moreover, empirical evidence suggests that short-run supply response tends to be relatively small partly due to lack of investment in other public institutions such as extension and infrastructure. Ruijs *et al.* (2004) found that although investing in road infrastructure to reduce transportation costs was beneficial, a clear improvement in food trade was only possible if market institutions were reformed. The urban households are not involved in agricultural production and hence their incomes do not change.

5. CONCLUSION AND POLICY IMPLICATION

The most noticeable impact of a policy shift towards legalizing informal milk trade is a reduction of the consumer price of milk by over 13 per cent. This in turn is likely to lead to increased milk consumption by about 15 per cent among both urban and rural households. This should lead to improved nutrition, particularly for the rural poor and especially children.

In addition, the reduced consumer price of milk will have an impact on the real incomes of consumers particularly those households where raw milk forms a large share of their expenditures. This is because they will spend less money to purchase a particular food package compared to when the transactions costs were higher.

Another important indirect impact it has on employment. Lower transaction costs make informal milk trade more lucrative, and hence more people are likely to join this business thereby creating various employment opportunities along the milk market chain.

The impact of the reduced transaction costs on the producers is small. However, there is an indirect impact on real incomes via the reduced consumer price of milk.

The results of this study imply that reduction in transaction costs associated with informal milk marketing is an effective policy that can be used to increase the welfare of poor consumers particularly in the short run. However, for such a policy to have a substantial impact on producers, long-term approaches should be considered and accompanied by investments in technology and other institutions.

6. RECOMMENDATIONS

There is need to collect more data, particularly on the behaviour of the informal milk agents, so that they can be explicitly modelled and the producer price of milk allowed to vary in the model based on markets forces and the resulting behaviour of the different players. This will lead to an increase of the impact the policy will have on producer prices and incomes.

In the current multi-market model, only the maize grain and housing markets were assumed to be directly or indirectly affected by changes in the milk market, and hence they were the only ones modelled alongside that of raw milk. However, there are other markets (e.g. pasteurized milk and maize meal markets) which are likely to be affected by changes in the policies on the marketing of raw milk. Again these were not modelled because of lack of sufficient data on them. There is need to collect the missing data and include them in the model.

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Appendix A

Overview of the multi-market model

The model used in this analysis is based on the generic multi-market platform developed by Rich and Lundberg (2002). In the model, there are five blocks of equations: prices, supply (and input demand), consumption, income and equilibrium. The price block relates producer and consumer prices in the domestic market and the relationships between world and domestic prices. The supply block characterizes production relationships in terms of the production of crops and milk and demand for inputs. The consumption block details household demand for different consumption goods. The income block defines total household income as the sum of agricultural and non-agricultural income, while the equilibrium condition equates supply plus net imports to household and input demand. The following is a listing of the variables used in the model:

C = all commodities (maize, milk, housing, labour, fertilizer, Napier and concentrates)
I = food and non-food products (i.e. non-input commodities, maize, milk and housing)
IA = food products only (maize and milk)
IM = importable products (fertilizer and concentrates)
IX = world price for importable commodities
NF = non-food products (housing)
IN = inputs (fertilizer, labour, Napier and concentrates)
P = production systems (subsistence, major dairy activities, limited dairying activities)
H = households (urban non-poor, urban poor, rural non-poor, rural poor)

PC_c	Consumer price for commodity *c*
PP_c	Producer price for commodity *c*
$RMARG_c$	Margin from rest-of-world (ROW) to border for commodity *c*
$IMARG_c$	Margin from consumption area to border for commodity *c*
$MARG_c$	Margin from producing area to consumption area for commodity *c*
PM_{im}	Import price for importable commodities
PX_{ix}	World price for importable commodities
tm_c	Import tariff on commodity *c*
er	USD-KSh exchange rate
$PSCR_{p,ia}$	Supply of food products (*ia*) by production system *p*
SCR_{ia}	Total supply of food products
$SIN0_{in}$	Total supply of input products (fixed)
$SHSE0_{nf}$	Total supply of housing (fixed)
$PDINP_{p,in,ia}$	Input demand of input *in* by production system *p* for crop *ia*
$DINP_{in,ia}$	Total input demand of input *in* for crop *ia*
$DFOOD_{H,,i}$	Demand for food and non-food product *i* by household group *h*
$CONS_i$	Total demand for food and non-food product *i*
M_c	Net imports of commodity *c*
YH_H	Total income of household group *h*
$YHNAG0_H$	Non-agricultural income of household group *h* (fixed)
$YHAGRP_H$	Agricultural income of rural poor
$YHAGRR_H$	Agricultural income of rural rich

Price block

The price block consists of three equations that relate producer and consumer prices in domestic markets and domestic prices to world prices. Producer prices are linked to consumer prices through the use of an exogenously specified margin (MARG) that is commodity-specific. This margin reflects various types of transactions costs that arise between the farm-gate and point of end sale, including transportation costs, mark-ups, etc. In the model, such margins also incorporate transactions costs in distribution encountered by different agents such as traders.

$$PP_c = \frac{PC_c}{(1 + MARG_c)} \tag{1}$$

In the model, all products except for fertilizer, milk and concentrates are assumed to be non-tradable. Thus, equilibrium in such markets arises from the intersection of supply and demand in domestic markets. For tradable goods, the consumer price is fixed to the world price for importables, whereas the producer price is fixed to the world price for exportable goods. These prices are adjusted by import margins, tariffs etc. through the following two price relationships:

$$PC_{im} = PM_{im} * (1 + IMARG_{im}) \tag{2}$$

$$PM_{im} = PW_{im} * er * (1 + RMARG_{im}) * (1 + tm_{im}) \tag{3}$$

Supply block

The model distinguishes between three production systems: subsistence farmers with limited dairy activities (SUBSIST); farmers with export crops and major dairy activities (MDAIRY); and farmers with intensified crop/export crops with limited dairy activities (LDAIRY). Each production system produces maize and milk through the use of commodity-specific inputs. Milk production requires the use of labour, Napier and concentrates, while maize uses just fertilizer and labour. Supply for each production system is modelled as a double-log system based on the prices of inputs and outputs, with the total supply of maize and milk simply the sum over each production system. The beta and the gamma coefficients represent the price elasticities for output and input prices, respectively.

$$\ln\left(PSCR_{p,ia}\right) = \alpha^s{}_{p,ia} + \sum_{ij} \beta^s{}_{p,ia,ij} \ln(PP_{ij}) + \sum_{in} \gamma^s{}_{p,ia,in} \ln(PC_{in}) \tag{4}$$

$$SCR_{ia} = \sum_p PSCR_{p,ia} \tag{5}$$

Likewise, the equations for input demand are represented in a double-log format, based on the production system and crop that uses each input. Input demand is a function of input demand consumer prices and output supply producer prices. Total input demand for each input by crop is the sum over each production system.

$$\ln\left(PDINP_{p,in,ia}\right) = \alpha^{I}{}_{p,in,ia} + \sum_{iin} \beta^{I}{}_{p,in,iin,ia} \ \ln(PC_{iin}) + \sum_{ij} \gamma^{I}{}_{p,in,ia,ij} \ln(PP_{ij}) \quad (6)$$

$$DINP_{in,ia} = \sum_{p} PDINP_{p,in,ia} \quad (7)$$

Consumption block

The model differentiates between four types of households: urban poor (URBPOOR), urban rich (URBRICH), rural poor (RURPOOR), and rural rich (RURRICH). Households consume both food products (maize and milk) and one non-food product, housing, that serves to proxy non-food expenditures. Consumption relationships are modelled as a double-log system based on the prices of food and non-food items and household income, using elasticities generated from the data mentioned previously.

$$DFOOD_{H,I} = \alpha^{D}_{H,I} + \sum_{j} \beta^{D}_{I,J,H} * \ln(PC_{j}) + \gamma^{D}_{H,I} \log(YH_{H}) \quad (8)$$

$$CONS_{I} = \sum_{H} DFOOD_{H,I} \quad (9)$$

Income block

Three equations characterize income in the model. Total income is the sum of agricultural and non-agricultural income; the latter is assumed to be exogenous. We assume that only rural households earn agricultural income, defined as the sum of total revenue from crop production less input use. For rural poor households, their income is based on the production from subsistence activities, while the income of rural rich households is based on the activities of major and limited dairy production systems.

$$YH_{H} = YHAGRP_{H} + YHAGRR_{H} + YHNAG0_{H} \quad (10)$$

$$YHAGRP_{RURPOOR} = \sum_{ia} \frac{PP_{ia} * PSCR_{subsist,ia}}{1000} - \sum_{in}\sum_{ia} \frac{PC_{in} * PDINP_{subsist,in,ia}}{1000} \quad (11)$$

$$\begin{aligned} YHAGRR_{RURRICH} &= \sum_{ia} \frac{PP_{ia} * PSCR_{mdairy,ia}}{1000} - \sum_{in}\sum_{ia} \frac{PC_{in} * PDINP_{mdairy,in,ia}}{1000} \\ &+ \sum_{ia} \frac{PP_{ia} * PSCR_{ldairy,ia}}{1000} - \sum_{in}\sum_{ia} \frac{PC_{in} * PDINP_{ldairy,in,ia}}{1000} \quad (12) \end{aligned}$$

Equilibrium block

An equilibrium condition closes the system that relates total supply plus net imports to household plus feed demand. Note that the supply of non-imported inputs and housing is fixed.

$$SCR_{ia} + SIN0_{in} + SHSE0_{nf} + M_{c} = CONS_{I} + DINP_{in,ia} \quad (13)$$

The model is programmed in GAMS (General Algebraic Modelling System) using a non-linear programming solver (CONOPT).